Floppy Disk Technologies and Information
Obsolete Floppy Drive Types

The following sections detail floppy disk drive technologies that are now obsolete.

5 1/4" Floppy Disk Construction

When you look at a typical 5 1/4" floppy disk, you see several things, as shown in Figure 1. Most prominent is the large, round hole in the center. When you close the disk drive’s “door,” a cone-shaped clamp grabs and centers the disk through the center hole. Many disks come with hub-ring reinforcements—thin, plastic rings that help the disk withstand the mechanical forces of the clamping mechanism. HD disks usually lack these reinforcements because the difficulty in accurately placing them on the disk means they can cause alignment problems.

On the right side, just below the center of the hub hole, is a smaller round hole called the index hole. If you carefully turn the disk within its protective jacket, you can see a small hole in the disk itself. The drive uses the index hole as the starting point for all the sectors on the disk—sort of the “prime meridian” for the disk sectors. A disk with a single index hole is a soft-sectored disk; the software (operating system) decides the actual number of sectors on the disk. Some older equipment, such as Wang word processors, use hard-sectored disks, which have an index hole to demarcate individual sectors. Do not use hard-sectored disks in a PC.

Below the hub hole is a slot shaped like a long racetrack through which you can see the disk surface. The disk drive heads read and write data to the disk surface through this media-access hole.

On the right side, about 1" from the top, is a rectangular punch from the side of the disk cover. If this write-enable notch is present, writing to the disk has been enabled. Disks without this notch (or with the notch taped over) are write-protected disks. The notch might not be present on all disks, particularly those purchased with programs on them.

On the rear of the disk jacket, at the bottom, two very small oval notches flank the head slot. These notches relieve stress on the disk and help prevent it from warping. The drive might also use these notches to assist in keeping the disk in the proper position in the drive.

**Figure 1** Construction of a 5 1/4" floppy disk.
360KB 5 1/4" Drives

The 5 1/4" double-density drive was designed to create a standard-format disk with 360KB capacity. The term double-density arose from the use of the term single-density to indicate a type of drive that used frequency modulation (FM) encoding to store approximately 90KB on a disk. This type of obsolete drive was never used in any PC-compatible systems but was used in some older systems, such as the original Osborne-1 portable computer. When drive manufacturers changed the drives to use modified frequency modulation (MFM) encoding, they began using the term double-density to indicate this, as well as the (approximately doubled) increase in recording capacity realized from this encoding method.

The 360KB 5 1/4" drives spin at 300rpm, which equals exactly 5 revolutions per second, or 200ms per revolution. All standard floppy controllers support a 1:1 interleave, in which each sector on a specific track is numbered (and read) consecutively. To read and write to a disk at full speed, a controller sends data at a rate of 250,000bps.

1.2MB 5 1/4" Drives

The 1.2MB high-density floppy disk drive first appeared in the IBM AT system introduced in August 1984. The drive required the use of a new type of disk to achieve the 1.2MB format capacity, but it still could read and write (although not always reliably) the lower-density 360KB disks.

The 1.2MB 5 1/4" drive usually recorded 80 cylinders of 2 tracks each, starting with cylinder 0 at the outside of the disk. This situation differs from the low-density 5 1/4" drive in its capability to record twice as many cylinders in approximately the same space on the disk. This capability alone suggests that the recording capacity for a disk would double, but each track normally is recorded with 15 sectors of 512 bytes each, increasing the storage capacity even more. In fact, these drives store nearly four times the data of the 360KB disks. The density increase for each track required the use of special disks with a modified medium designed to handle this type of recording. Because these disks initially were expensive and difficult to obtain, many users incorrectly attempted to use the low-density disks in the 1.2MB 5 1/4" drives and format them to the higher 1.2MB-density format, which resulted in data loss and unnecessary data recovery operations.

A compatibility problem with the 360KB drives stems from the 1.2MB drive's capability to write twice as many cylinders in the same space as the 360KB drives. The 1.2MB drives position their heads over the same 40 cylinder positions used by the 360KB drives through double stepping, a procedure in which the heads are moved every 2 cylinders to arrive at the correct positions for reading and writing the 40 cylinders on the 360KB disks. The problem is that, because the 1.2MB drive typically must write 80 cylinders in the same space in which the 360KB drive writes 40, the heads of the 1.2MB units had to be made dimensionally smaller. These narrow heads can have problems overwriting tracks produced by a 360KB drive that has a wider head because the narrower heads on the 1.2MB drive cannot “cover” the entire track area written by the 360KB drive.

The 1.2MB 5 1/4" drives spin at 360rpm, which is 6 revolutions per second, or 166.67ms per revolution. To send or receive 15 sectors (plus the required overhead) six times per second, a controller must use a data transmission rate of 500,000bps (500KHz). All standard high- and low-density controllers support this data rate and, therefore, these drives.

This support also depends on proper ROM BIOS support of the controller in this mode of operation. When a standard 360KB disk is running in an HD drive, it also is spinning at 360rpm. Consequently, a data rate of 300,000bps (300KHz) is required to work properly. All standard AT-style low- and high-density controllers support the 250KHz, 300KHz, and 500KHz data rates. The 300KHz rate, however, is used only for HD 5 1/4" drives reading or writing to low-density 5 1/4" disks.
720KB 3 1/2" Drives

The 720KB, 3 1/2", DD drives first appeared in an IBM system with the IBM Convertible laptop system introduced in 1986. In fact, all IBM systems introduced since that time have 3 1/2" drives as the standard supplied drives.

Note
Outside the PC-compatible world, other computer system vendors (Apple, Hewlett-Packard, and so on) offered 3 1/2" drives for their systems two years before the PC-compatible world caught on.

The 720KB, 3 1/2", DD drive usually records 80 cylinders of 2 tracks each, with 9 sectors per track, resulting in the formatted capacity of 720KB.

PC-compatible systems have used 720KB, 3 1/2" DD drives primarily in XT-class systems because the drives operate from any low-density controller. The drives spin at 300rpm and therefore require only a 250KHz data rate from the controller to operate properly. This data rate is the same as the 360KB disk drives, so any controller that supports a 360KB drive also supports the 720KB drives.

2.88MB 3 1/2" Drives

The 3 1/2", 2.88MB drive was developed by Toshiba Corporation in the 1980s and was officially announced in 1987. Toshiba began production manufacturing of the drives and disks in 1989, and several vendors began selling the drives as upgrades for their systems. IBM officially adopted these drives in its PS/2 systems in 1991, and a number of manufacturers began making them, including Toshiba, Mitsubishi, Sony, and Panasonic. Because a 2.88MB drive can fully read and write 1.44MB disks, the change is an easy one. Unfortunately, because of high media costs and a relatively low increase in data capacity, these drives never caught on widely, although virtually all systems today have built-in support for them. DOS version 5.0 or Windows 95 or later is required to support the 2.88MB drives.

The 2.88MB extra high-density (ED) drive uses a technique called vertical recording to achieve its great linear density of 36 sectors per track. This technique increases density by magnetizing the domains perpendicular to the recording surface. By essentially placing the magnetic domains on their ends and stacking them side by side, the disk density increases enormously. This technique, also called perpendicular recording, is being considered for future use in hard disk drives as a method of increasing capacity. See Chapter 10, “Hard Disk Storage,” for details.

The technology for producing heads that can perform a vertical or perpendicular recording has been around for some time. But it is not the heads or even the drive that represents the major breakthrough in technology; rather, it is the medium that is special. Standard disks have magnetic particles shaped like tiny needles that lie on the surface of the disk. Orienting these acicular particles in a perpendicular manner to enable vertical recording is very difficult. The particles on a barium-ferrite floppy disk, on the other hand, are shaped like tiny, flat, hexagonal platelets that can more easily be arranged to have their axes of magnetization perpendicular to the plane of recording.

Toshiba perfected a glass-crystallization process for manufacturing the ultra-fine platelets used in coating the barium-ferrite disks. This technology, patented by Toshiba, is being licensed to several disk manufacturers, all of whom are producing barium-ferrite disks using Toshiba’s process. Toshiba also made certain modifications to the design of standard disk drive heads to enable them to read and write the new barium-ferrite disks, as well as standard cobalt or ferrite disks. This technology is being used not only in floppy disk drives, but also in a variety of tape drive formats.
The disks are called 4MB disks in reference to their unformatted capacity. The actual formatted capacity is 2880KB, or 2.88MB. Because of space lost in the formatting process—as well as space occupied by the volume boot sector, FATS, and root directory—the total usable storage space is 2863KB.

To support the 2.88MB drive, modifications to the disk controller circuitry were required because these drives spin at the same 300rpm but have an astonishing 36 sectors per track. Because all floppy disks are formatted with consecutively numbered sectors (1:1 interleave), the drive must read and write 36 sectors in the same time it takes a 1.44MB drive to read and write 18 sectors. This requires that the controller support a much higher data transmission rate of 1MHz (one million bps). Most older floppy controllers support only the maximum data rate of 500KHz used by the 1.44MB drives. To upgrade to a 2.88MB drive, the controller must be changed to one that supports the higher 1MHz data rate.

An additional support issue is the ROM BIOS. The BIOS must have support for the controller and the capability to specify and accept the 2.88MB drive as a CMOS setting.

Virtually all modern PCs have built-in floppy controllers and ROM BIOS software that fully support the 2.88MB drives. Adding or upgrading to a 2.88MB drive in these systems is as easy as plugging in the drive and running the CMOS Setup program. For systems that do not have this built-in support, the upgrade process is much more difficult. Several companies offer new controllers and BIOS upgrades as well as the 2.88MB drives specifically for upgrading older systems. Keep in mind, though, that locating 2.88MB media is extremely difficult these days. Unless you need this size of drive for data interchange with another user, a USB thumb drive or a CD-RW/DVD rewriteable is a much more flexible storage medium.

Troubleshooting Floppy Drives

Because of their low cost, floppy drives have become a fairly disposable item these days. Also, their connection to the system has become simpler over the years because drives today come preconfigured with no jumpers or switches to set. The cables are fairly standardized as well. Therefore, if the drive or cable is suspected of being defective, it should be replaced rather than repaired. This section discusses some of the most common problems floppy drives can have and how to troubleshoot them.

Common Problems

Problem

Dead drive—The drive does not spin and the LED never comes on.

Cause/Solution

The drive or controller is not properly configured in the BIOS Setup. Check the BIOS Setup for proper drive type, and make sure the controller is enabled if it's built in to the motherboard.

Other causes for a dead drive include

- **Bad power supply or power cable.** Measure the power at the cable with a voltmeter, and ensure that 12V and 5V are available to the drive.
- **Bad data cable.** Replace the cable and retest.
- **Defective drive.** Replace the drive and retest.
- **Defective controller.** Replace the controller and retest. If the controller is built in to the motherboard, disable it via the BIOS Setup, install a card-based controller, and retest; or you might need to replace the entire motherboard and retest.
**Problem**

*Drive LED remains on continuously.*

**Cause/Solution**

Data cable is on backward at either the drive or controller connection. Reinstall the cable properly and retest.

Also, the data cable could be offset on the connector by one or more pins. Reinstall the cable properly and retest. If this does not solve the problem, it could be a defective cable. Replace the cable and retest.

**Problem**

*Phantom directories—you have exchanged disks in the drive, but the system still believes the previous disk is inserted and even shows directories of the previous disk.*

**Cause/Solution**

Several causes and solutions are possible:

- **Defective cable (pin 34).** Replace the cable and retest.
- **Improper drive configuration.** If the drive is an older model and has a DC jumper, it must be set to enabled. You also should ensure that the BIOS Setup has the proper drive type entered.
- **Defective drive.** Replace the drive and retest.

**Common Error Messages**

**Error Message**

*Invalid Media or Track Zero Bad, Disk Unusable*

**Cause/Solution**

You are formatting the disk, and the disk media type does not match the format parameters. Be sure you are using the correct type of disk for your drive and formatting the disk to its correct capacity. Other causes and solutions are

- **Defective or damaged disk.** Replace the disk and retest.
- **Dirty heads.** Clean the drive heads and retest.

**Error Message**

*CRC Error or Disk Error 23*

**Cause/Solution**

The data read from the disk does not match the data that was originally written. (CRC stands for cyclic redundancy check.) Replace the disk and retest or, possibly, clean the drive heads. Use the Norton Utilities for possible data recovery from the disk.

**Error Message**

*General Failure Reading Drive A, Abort, Retry, Fail or Disk Error 31*

**Cause/Solution**

The disk is not formatted or has been formatted for a different operating system (Macintosh, for example). Reformat the disk and retest. Another cause could be that damaged areas exist on the disk medium. Replace the disk and retest. Use the Norton Utilities for possible data recovery from the disk.
**Error Message**
Access Denied

**Cause/Solution**
You are trying to write to a write-protected disk or file. Move the write-protect switch to allow writing on the disk, or remove the read-only file attribute from the files. File attributes can be changed with the `ATTRIB` command.

**Error Message**
Insufficient Disk Space or Disk Full

**Cause/Solution**
The disk is filled, or the root directory is filled. Check to see whether sufficient free space is available on the disk for your intended operation.

**Error Message**
Bytes in Bad Sectors

**Cause/Solution**
This is displayed after formatting or running the `CHKDSK` command and shows that the disk has several allocation units that are marked bad. This is not a problem in itself because, when the allocation units are marked in this fashion, the operating system will not use them for file storage. Even so, I normally don’t recommend using disks with bad sectors.

**Error Message**
Disk Type or Drive Type Incompatible or Bad

**Cause/Solution**
You are attempting to `DISKCOPY` between two incompatible drive or disk types. Disks can be copied only between drives using the same disk density and size.